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# The effects of etiological factors on timing of decortication

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## ABSTRACT

**Aims**: Tube drainage is the primary method in the treatment of empyema with 80-90% cure rates. In patients with empyema who have not received adequate treatment, the result is pleural fibrosis. Decortication is the only treatment option for chronic empyema that has caused fibrothorax that prevents lung expansion. In our study, we aimed to determine the relations between etiological base of the disease, the consequences and the decision of decortication timing.

**Methods**: The patients who were admitted and hospitalized with pleural effusion between 1994 and 2000 were included in the study. We examined the duration of pretreatment, pleural thickness and the duration of postoperative hospital stay of these cases, with who have undergone decortication surgery.

**Results**: A total of 82 cases of decortication were enrolled, which consisted of 61 male (74.3%) and 21 female (25.6%). The cases were examined in two groups: tuberculosis [12 (25%) empyema, 27 (56.3%) tuberculous pachypleuritis, 9 (18.8%) pleurisy + parenchymal involvement] and non-tuberculosis [2 (5.9%) trauma, 5 (14.7%) pneumonia + empyema, 23 (%) 67.6% empyema, 4 (11.8%) hydatid cyst]. The effects of preoperative treatment durations on the thickness of the decortication materials and the duration of postoperative hospital stay were investigated. The preoperative treatment period of the tuberculosis group was significantly higher, the decortication pleural thicknesses were found to be greater. ($p<0.01$) There was no statistically significant difference in the duration of postoperative hospital stay between the tuberculosis and other group ($p>0.05$).

**Conclusion**: In cases that do not respond to closed tube drainage and appropriate antibiotic therapy, decortication should be performed without delay considering the etiological factors. If decortication is performed earlier than 2 weeks, the visceral pleura can be easily separated; parietal decortication is rarely needed which might be an advantage of the procedure.

**Keywords**: Tuberculosis, empyema, decortication, pleural thickness

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## INTRODUCTION

Pleural effusions are the most common pleural disease and may develop due to many intrathoracic and systemic diseases. Thoracentesis is made for differential diagnosis; according to the nature of the effusion whether it is transudate or exudate. Transudates are formed because of an increase in hydrostatic pressure or a decrease in osmotic pressure in this barrier (such as congestive heart failure, nephrotic syndrome, atelectasis, hepatic hydrothorax, peritoneal dialysis effusions). They usually indicate that the pleural membranes themselves are not defective. Exudates, conversely, are formed due to the leakage of fluid and protein from an altered, increased permeability barrier. Pneumonia, pulmonary embolism, malignancies, esophageal rupture, chylothorax, ascites, and bacterial peritonitis are some courses in the exudate category. Lymphatic obstruction may accompany accumulation of effusion in both transudates and exudates.

As a result of the presence of fluid in the pleural space, the lung volumes decrease, being less than the volume of the pleural fluid, and restrictive ventilation disorder occurs. Pleuritic chest pain, cough, and dyspnea are the common symptoms. The prognosis varies according to the etiology of all pleural effusions. Exudative pleural effusions (tuberculosis, empyema, hemothorax) often result in pleural thickening. Empyema develop in three stages: exudation, fibrinopurulent, and organization.

Contrast-enhanced thorax computed tomography (CT) has an important role in detecting changes in the chest wall and parietal pleura in patients with empyema and influences therapeutic decisions. The thickened extrapleural fatty tissue layer is used as a basis for measuring the parietal pleural thickness in Thorax CT sections. It is also possible to show bronchopleural fistula tracts with Thorax CT.[1] Empyema is the presence of pus in the pleural space, 60%

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is the result of complicated parapneumonic effusion, 20% occurs after thoracic surgery, the remaining 20% occurs after thoracic trauma, thoracentesis, esophageal perforation, subdiaphragmatic infection. The most important point in the evaluation of complicated parapneumonic effusions is the decision of whether to apply tube drainage or not. The primary method in the treatment of empyema is tube thoracostomy with 80-90% cure rates.[2,3]

Fibrinolytic therapy can be tried in the organizational phase of empyema. In patients with empyema who have not got adequate treatment, the result is pleural fibrosis. Because of the thickened pleura, that hemithorax volume and its expansion decrease, and the mediastinum is pulled to that side.[2] The main functional disorder that occurs is not only the direct inhibition of the expansion of the lung, but also the contraction of the diaphragm, which is the most important muscle of inspiration. Insufficient contraction of the diaphragm on the one hand results in a restrictive ventilation disorder, on the other hand, it causes deterioration in mucociliary clearance and recurrent bronchitis with the deterioration of cough mechanism.[4,5] Tuberculous pleurisy accounts for approximately 10% of patients with tuberculosis and is still the most common cause of exudative pleurisy in many parts of the world. The precise distinction between tuberculous pleurisy and tuberculous empyema is essential before the decision of the treatment.

At the end of the 6-8 weeks of the disease course, varying amounts of fibrous tissue begin to form in the pleura in a significant proportion of these patients.[3] The degree of fibrosis changes depending on the extent of the inflammatory reaction in the pleura, the status of the infection in the lung parenchyma and the adequate medical treatment.[3] If the duration extends, fibroblasts proliferate and settle around the thickened pleura, tending to form a thick-walled loculated pleural collection. This is especially seen in patients with tuberculous pleurisy who had got inadequate treatment. Calcification and fibrothorax often develop in the parietal and visceral pleura in patients with chronic tuberculous empyema. In patients with tuberculous pleurisy, pleural fluid may resolve with medical treatment, so the decision for decortication should be left for 6-12 months after treatment. Approximately 1% of patients may develop fibrothorax after traumatic or iatrogenic hemothorax.

Although several months can be expected for spontaneous resolution of the pleural thickening, decortication is still the only treatment option in chronic empyema that prevents lung expansion, impairs respiratory functions, and causes fibrothorax. Lung tissue must not have remained under the thick pleural tissue for more than six months in order to expand after decortication6. Studies in the literature show that the results of early decortication are satisfactory in cases with closed tube drainage and empyema that do not respond to medical treatment.[6-9] The widespread use of video thoracoscopic surgery (VATS) has brought a new dimension to the treatment of thoracic empyema. While helping to differentiate between acute and chronic empyema by exploration of the pleural space, it also made it possible to treat acute empyema with thoracoscopic debridement and irrigation.[10-12] Several studies reveal that decortication with VATS gives good results for both the patient and the operator in localized empyema that are not located in the diaphragm.[9] The decortication procedure should be considered in patients who require additional drainage after tube thoracostomy or thoracoscopy. Decortication eliminates pleural sepsis and allows the underlying lung tissue to expand. However, it is a major thoracic surgery, and the risk of the operation, the age and the general condition of the patient should be under consideration for decision. Although the risk of complications in the early period is lower, no significant difference was observed between the operations performed in the early or late period in terms of affecting respiratory functions.[13,14]

## METHODS

Since there was no Ethics Committee in our hospital in the year 2000 when the study was conducted, the study was carried out under the permission and supervision of the responsible Clinical Chief.

The study was conducted in a single center. The patients who had undergone decortication between January 1994 and July 2000, in Heybeliada Chest Diseases and Thoracic Surgery Center were enrolled. These patients were examined retrospectively from the database of the hospital. All the cases included in the study had preoperative contrast enhanced thorax CT.

According to the postoperative histopathological results of the cases, they were grouped into two groups specific (tuberculosis) and nonspecific (chronic pleuritis, intrapleural hydatid cyst rupture, diffuse malignant mesothelioma=non-tuberculosis).

The effects of the duration of preoperative treatment on the thickness of the decortication material and postoperative hospital stay were investigated in each group. Thorax CTs of all cases were reported by the same radiologist, and pleural thickening measurements in CT were compared with pleural thicknesses in postoperative histopathological evaluations.

Since there was no Ethics Committee in our hospital in the year 2000 when the study was conducted, the study was carried out under the permission and supervision of the responsible Clinical Chief.

### Statistical Analysis

While evaluating the study data, besides descriptive statistical methods (mean, standard deviation), the t-Student test and Mann Whitney-u test were used to

compare quantitative data. Pearson correlation analysis was applied to calculate the correlation coefficients. The Chi-square test was used to compare qualitative data. The results were evaluated at the 95% confidence interval and the significance level at p<0.05.

## RESULTS

A total of 82 cases between 18-71 years (average 33.79), were included in the study. It consisted of 48 cases with tuberculosis and 34 cases with non-tuberculosis etiology who had undergone decortication. In the group of tuberculosis cases, 12 (25%) were empyema, 27 (56.3%) had pachypleuritis, 9 (18.8%) had pleurisy + parenchyma involvement. The lesion distribution of non-tuberculosis cases is; 2 (5.9%) trauma, 5 (14.7%) pneumonia +empyema, 23 (67.6%) empyema, 4 (11.8%) hydatid cyst (Table 1).

**Table 1.** Distribution of tuberculosis and non-tuberculosis cases according to lesion types

| **Tuberculosis** | **N** | **%** |
|---|---|---|
| Empyema | 12 | 25 |
| Tuberculosis pachypleuritis | 27 | 56.3 |
| Pleurisy + Parenchyma involvement | 9 | 18.8 |
| Total | 48 | 100 |
| **Non-Tuberculosis group** | **N** | **%** |
| Trauma | 2 | 5.9 |
| Pneumonia + Empyema | 5 | 14.7 |
| Empyema | 23 | 67.6 |
| Hydatid cyst | 4 | 11.8 |
| Total | 34 | 100 |

While the mean age of the tuberculosis group was 29.21+12.20, the mean age of the non-tuberculosis cases was 40.26+19.46. While the tuberculosis group consisted of 35 male (72.9%) and 13 female (27.1%) patients, the non-tuberculosis group consisted of 26 male (76.5%) and 8 female (23.5%) patients. Most of the cases were male in both groups (72.9%, 76.5% respectively). While there was a statistically significant difference between the groups according to the mean age (p<0.05), there was no significant difference in the distribution according to the genders (p>0.05) (Table 2).

**Table 2. Demographic data of the groups**

| | | Tuberculosis group n=48 | Non-tuberculosis group n=34 | p |
|---|---|---|---|---|
| Age (mean±standard deviation) | | 29.21±12.20 | 40.26±19.46 | 0.02; p<0.05* |
| Gender | Male | 35 (72.9%) | 26 (76.5%) | 0.716 |
| | Female | 13 (27.1%) | 8 (23.5%) | p>0.05 |

The mean preoperative treatment duration of the tuberculosis group was 2.42±2.08 months for the tuberculosis group, and 0.63±0.29 months for the non-tuberculous cases. A statistically significant difference was found between the groups in terms of preoperative treatment duration (p<0.001). The number of untreated cases in the preoperative period was 1 (2.1%) in the tuberculosis group and 6 (17.6%) in the non-tuberculosis group; the number of cases who underwent tube thoracostomy was 4 (8.3%) in the tuberculosis group and 5 (14.7%) in the non-tuberculosis group, and they were not included in the statistical evaluations of treatment periods (Table 3).

**Table 3.** Distribution of groups according to duration of preoperative treatment

| | **n** | **Mean±Standard Deviation (month)** | **p** |
|---|---|---|---|
| Tuberculosis | 47 | 2.42±2.08 | 0.0001** p<0.0001 |
| Non-tuberculosis | 28 | 0.63±0.29 | |

**p<0,01 highly significant

There was a statistically significant difference between the two groups in terms of the time of decortication and pleural thickness (p<0.01). In tuberculosis cases, the time of decortication was found to be later and pleural thicknesses were found to be greater (Table 4).

**Table 4.** Distribution of groups according to the timing of decortication and pleural thickness

| | **Groups** | **Mean±standard deviation** | **p** |
|---|---|---|---|
| Timing of decortication | Tuberculosis | 4.58±4.39 | 0.008 |
| | Non-tuberculosis | 2.39±2.00 | p<0.01** |
| Pleural thickness | Tuberculosis | 14.73±5.37 | 0.005 |
| | Non-tuberculosis | 11.38±4.88 | p<0.01** |

**p<0,01 highly significant

There was no statistically significant difference between tuberculosis (Mean±Std. Deviation 15.81±13.6 days) and non-tuberculosis groups (Mean±Std. Deviation 18.17±16.9 days) in terms of hospital stay in the postoperative period (p>0.05) (Table 5).

**Table 5.** Distribution of groups according to postoperative hospital stay

| | **n** | **Mean±Standard Deviation (day)** | **p** |
|---|---|---|---|
| Tuberculosis | 48 | 15.81±13.6 | 0.777 |
| Non-tuberculosis | 34 | 18.17±16.9 | p>0.05 |

When the relationship between the duration of preoperative treatment, the time of decortication, pleural thickness and postoperative hospital stay of the cases were examined: There was a positive, good, statistically significant correlation between the preoperative treatment periods of the tuberculosis cases and the decortication timing (r=0.601; p<0.01). There was no correlation between the duration of preoperative treatment and pleural thickness (r=0.032; p>0.05) and postoperative hospital stay (r=-0.165; p>0.05) (Table 6).

**Table 6.** Distribution of correlation between duration of treatment and timing of decortication, pleural thickness and postoperative hospital stay in tuberculosis cases

| | Duration of treatment correlation coefficient (r) | p |
|---|---|---|
| Timing of decortication | 0.601 | 0.0001; p<0.01** |
| Pleural thickness | 0.032 | 0.829; p>0.05 |
| Postoperative hospital stay | -0.165 | 0.268; p>0.05 |

While there was a positive, moderate and statistically significant correlation between the duration of preoperative treatment and the time of decortication in non-tuberculosis cases (r=0.385; p<0.05), there was no correlation between the duration of treatment, pleural thickness (r=0.104; p>0.05), and the patient's postoperative mortality (Table 7).

**Table 7.** Distribution of correlation between duration of treatment and timing of decortication, pleural thickness and postoperative hospital stay in non-tuberculosis cases

| | Duration of treatment correlation coefficient (r) | p |
|---|---|---|
| Timing of decorticaiton | 0.385 | 0.043; p<0.05* |
| Pleura thickness | 0.104 | 0.829; p>0.05 |
| Postoperative hospital stay | -0.017 | 0.268; p>0.05 |

There was no statistically significant correlation between pleural thickness and postoperative hospital stay in both groups (p>0.05) (Table 8).

**Table 8.** Distribution of correlation between postoperative hospital stay and pleural thickness according to groups

| | Correlation of pleural thickness Coefficient: (r) | p |
|---|---|---|
| Postoperative hospital stay of Tuberculosis cases | -0.006 | 0.968; p>0.05 |
| Postoperative hospital stay of Non-Tuberculosis cases | -0.238 | 0.175; p>0.05 |

A statistically significant difference was found between the pleural thickness measured in Thorax CT (Mean±Std. Deviation 7.7±3.76) and decortication material pleural thickness (mean±std. Deviation 13.34±5.4) in all cases (p<0.001) (Table 9).

**Table 9.** Distribution of relation between pleural thickness in thorax ct and pleural thickness of decortication material in all cases

| | n | Mean±Standard Deviation | p |
|---|---|---|---|
| Pleural thickness in Thorax CT | 82 | 7.70±3.76 | 0.0001 p<0.0001 |
| Pleural thickness of decortication material | 82 | 13.34±5.40 | |

3 cases (6.25%) in the tuberculosis group and 4 cases (11.7%) in the non-tuberculosis group developed postoperative complications.

## DISCUSSION

Thoracic empyema is an ancient disease known since the Hippocratic period, and the most common cause is lung infections. Empyema still has significant morbidity and mortality rates; The development of modern antibiotic therapy has reduced the incidence of thoracic empyema.[10,11] The basic principle in treatment is drainage. Factors such as delay in drainage or insufficient drainage make the event chronic and reach more serious dimensions.[15-18] As exudative effusions can transform into multiloculated fibrinopurulent effusions within days timing is critical in the drainage of complicated parapneumonic effusion.[19] Considering the etiological factors, in cases where there is no response to closed tube drainage and appropriate antibiotic therapy, decortication should be performed without delay.[20,21]

The stages of the pleura are important in decortication surgery. While the decorticated tissue can be easily separated from the pleura between 2-4 months of the disease, fibrous bands develop between the fibrin layer on the visceral pleura and the septa of the parenchyma below it between 4-6 months. In the first months, these bands can be easily separated by blunt dissection in the operations. Since the parenchyma is also involved in late operated cases, the alveoli can also be peeled off together with the visceral pleura.[22,23]

Therefore, as the decortication decision is delayed, the frequency of complications such as postoperative bronchopleural fistula, infection, bleeding, and alveolar leaks increase; drainage and length of hospital stay are prolonged.[24,25] In 82 decortication cases that we examined retrospectively in our study; In terms of the effects of pleural thickening and the timing of decortication on morbidity and mortality, some of our results were similar to previous studies in the literature and some were not.

The main purpose of this study was to examine the effects of delay in surgical intervention and choice of operation on morbidity. In our study, the mean age of the tuberculosis group was (29.2) considerably lower than the non-tuberculous group (40.2) and consisted of young people. There was significant male gender dominance in both groups. Although the average age for pleural tuberculosis tends to increase both in our country and in developed countries, it is more common in young people (18-38 years old).[26,27] In another group's study to predict residual thickening in pleural tuberculosis, the mean age was found to be 35.8, and in Al-Kattan's tuberculosis empyema series,

the mean age was found to be 33.8.[26,28] In our study, the duration of preoperative treatment was found to be longer in the tuberculosis group than in the nontuberculous group.

The number of preoperative untreated cases was higher in the non-tuberculosis group. In the decortication series previously performed in our hospital, consisting of 140 men and 57 women, the preoperative treatment period of tuberculosis cases was found to be longer than the non-tuberculosis group, similar to our study.[15] Different researchers preferred to place a small thoracostomy tube with Thorax CT as an initial drainage option, and to add fibrinolytics when loculation develops.[29] VATS can be preferred in fibrinopurulent effusions. However, the opinion of the studies is that decortication is definitely indicated in patients with organized parapneumonic pleural effusion, who developed systemic symptoms and ventilatory disorder, and gradually increasing pleural thickening in these patients should not be forgotten.

It is observed that postoperative drainage times are longer and complications such as expansion defect and empyema reactivation are more common in patients receiving antituberculosis therapy for more than six months. It should not be forgotten that the condition of the underlying parenchyma is as important as the event in the pleura in pleural tuberculosis; If there is no clinical, radiological or bacteriological parenchymal tuberculosis or it has been cured, decortication should not be performed.[5,8] In our study, the thickness of the decorticated material was found to be significantly greater in the tuberculosis group than in the non-tuberculous group, which was associated with a more progressive course of the disease in tuberculosis. In the study of Sohaila et al.[20] no significant correlation was found between the duration of antituberculosis treatment received by patients and pleural thickening.

Thorax CT pleural thickness and mean hospital stay found in Al-Kattan's tuberculosis empyema series were similar to those in our study.[28] In the study of Martinez and Corderon,[29] in which they examined residual pleural thickening after parapneumonic effusion, the pleural thickness was found similar to our study. In our study, the time to decide on decortication was prolonged as the preoperative treatment time increased in both groups; however, no correlation was found between preoperative treatment times, decortication material thickness, and postoperative hospital stay. Similarly, in different series, it was shown that the postoperative drainage time gets longer as the pleural thickness increases in tuberculosis cases but no significant correlation was found in the non-tuberculous group.[30] In this present study, the pleural thickness measured in Thorax CT was smaller than the pleural thickness in the decorticated material.

Tube drainage and even thoracentesis alone may be sufficient in some empyema cases in the exudation phase; even tube drainage can still be tried in the fibrinopurulent phase, but only open drainage or decortication can be effective in the organization phase. Today, many data suggest that delay in surgical intervention in the organization phase increases morbidity. Burford et al.'s[31] study results support the effectiveness of early decortication, which showed low morbidity and mortality rates. In the decortication case series of Musgera et al.[32] in pachypleuritis, it was shown that the postoperative results deteriorate, when the duration of symptoms is prolonged and no correlation was found with the etiology. In our study, two mesothelioma cases preoperatively histopathologically diagnosed with chronic nonspecific pleuritis, differ from the others because of their pleural thickness and the nodular and irregular thickening. Again, the thickness of the decortication materials of the hydatid cyst cases in our study was found to be close to the group average, unlike the previous series. Early decortication of perforated hydatid cysts plays an important role in these results.

If tube drainage fails to expand the lung, early decortication is performed under appropriate antibiotic therapy. Here the main purpose is; the elimination of empyema, re-expansion of the lung, re-mobilization of the chest wall and diaphragm, normalization of respiratory functions, reduction of complications or the risk of chronicity, and shortening of hospital stay.

## CONCLUSION

Tuberculous pleurisy, pyogenic empyema and traumatic hemothorax are the main causes of fibrothorax. Thickening and sticking pleural layers and the organized fibrin layer between them restrict the expansion of the lung and thorax, creating a restrictive type of respiratory disorder. Although thoracic CT is a good guide for pleural thickening, in the decortication decision the clinician's clinical and radiological evaluation is essential. There may be no need for decortication in a significant part of tuberculous pleurisy cases when they are followed up under medical treatment for a sufficient period. The opinion is that decortication should be performed in the early period in order to eliminate sepsis and provide expansion of the lung in pyogenic empyemas where pleural sepsis cannot be controlled with closed tube drainage.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** Since there was no Ethics Committee in our hospital in the year 2000 when the study was conducted, the study was carried out under the permission and supervision of the responsible Clinical Chief.

**Informed Consent:** Because the study was designed retrospectively, no written informed consent form was obtained from patients.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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**Author Contributions:** All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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